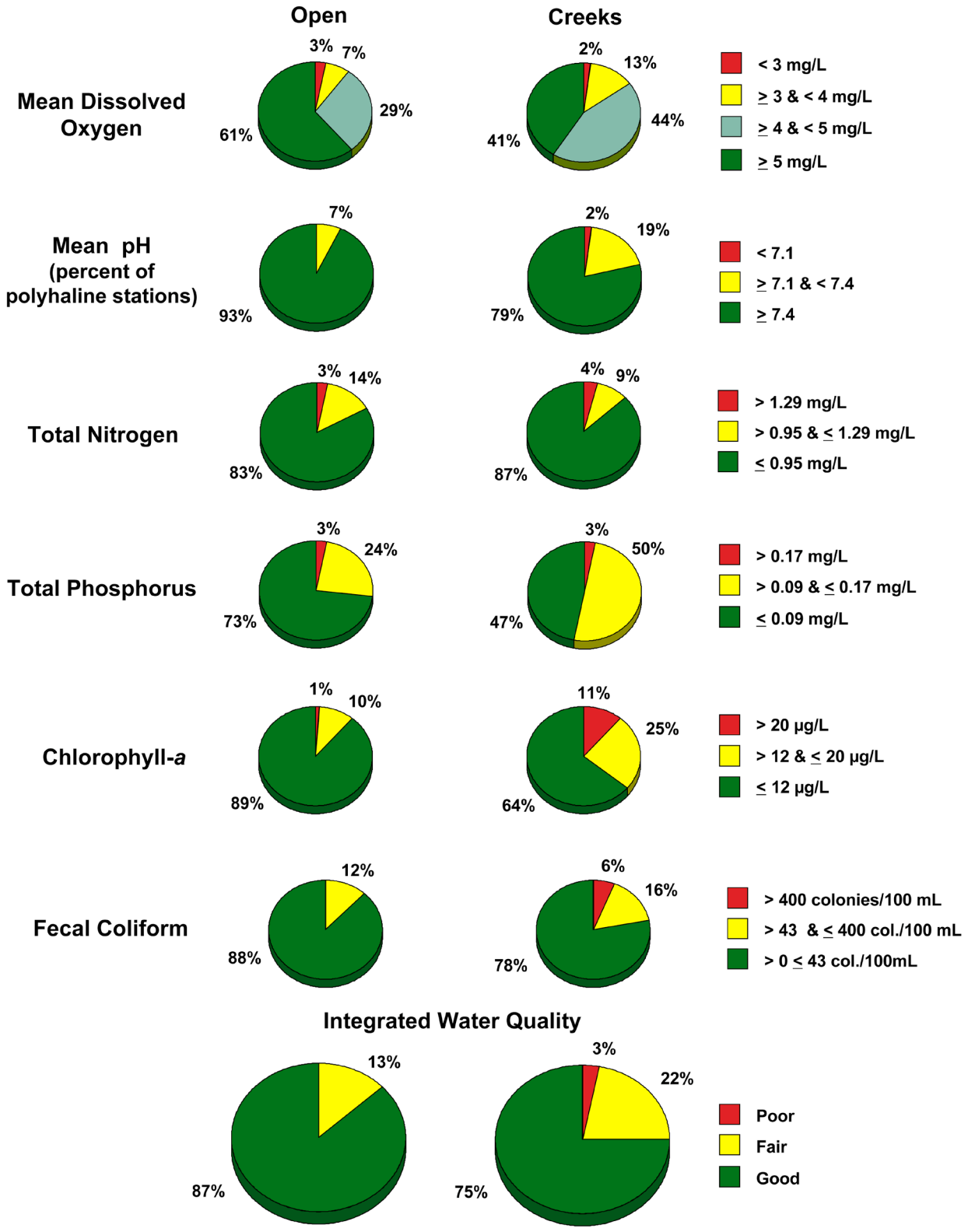

Figure 3.2.2. Comparison of the percent of the state's coastal habitat that represented various water quality conditions for selected water quality parameters and for the integrated water quality index.

anthropogenic inputs remains unclear and deserves further attention.

Tidal creek sites with very high TP concentrations were located in the upper Ashley River near Runnymede Plantation and Middleton Gardens (RT032046, RT041294; Appendix 2). This latter creek also had very high total nitrogen concentrations. Open water sites with very high TP concentrations were near the mouth of the Pee Dee River and in Winyah Bay near Belle Isle Gardens (RO046062, RO046064; Appendix 2).

Chlorophyll-a

Our measure of phytoplankton biomass in the water column is based on chlorophyll-*a* concentrations. Other phytoplankton pigments were also examined using HPLC analyses to determine phytoplankton composition (see Section 3.4). High chlorophyll-*a* concentrations provide an indication of possible estuarine eutrophication since phytoplankton respond rapidly to enriched nutrient concentrations and can form blooms that result in poor water quality (e.g., low DO, large DO variations) and the presence of harmful algal species. For SCECAP, chlorophyll-*a* concentrations $\leq$ 12 µg/L are considered to be good. Chlorophyll-*a* values > 12 µg/L represent the upper 75th percentile of all chlorophyll-*a* concentrations measured by the SCECAP program and are considered to be only fair. Chlorophyll-*a* concentrations above 20 µg/L are considered to be high or poor based on criteria or guidelines published by Bricker *et al.* (1999) and the USEPA (2004).

The mean chlorophyll-*a* concentration was 11.8 µg/L in creek habitats and 7.6 µg/L at the open water sites. This difference was statistically significant ($p < 0.001$), but both means represent relatively low concentrations based on the SCECAP database (i.e., < 75th percentile). Using SCECAP criteria, 11% of the state's tidal creek and 1% of the open water habitat had chlorophyll-*a* concentrations considered to be poor (Figure 3.2.2). The slightly higher chlorophyll concentrations in tidal creeks may be reflective of the higher nutrient concentrations observed in the creeks. It may also reflect possible re-suspension of benthic algae from the creek bottoms and nearby marsh surfaces.

An analysis of the relationships between total nutrient concentrations and chlorophyll-*a* concentrations using all six years of available data showed very little correlation between TN and chlorophyll-*a* concentrations (r^2 =0.0185) or between TP and chlorophyll-*a* concentrations (r^2 = 0.0143) (Figure 3.2.5). This is similar to the findings obtained by Van Dolah *et al.* (2004a) in previous survey periods of estuarine habitats. Similarly, Brock (2005) could find no relationships between phosphorus and chlorophyll-a concentrations in brackish stormwater ponds in SC. Therefore, the poor relationships between TN and TP and chlorophyll-a suggest a need to reconsider the utility of using nutrient concentrations as indicators of eutrophication. The lack of a good correlation with either nutrient parameter is likely due to a combination of nutrient-algae dynamics and the high tidal amplitude present in South Carolina estuaries, the latter of which reduces formation of blooms that might otherwise occur in more stagnant waters or in estuaries that have much lower tidal flow.

Fecal Coliform Bacteria

Fecal coliform bacteria are sampled as a measure of potential health hazard in estuarine waters related to primary contact recreation such as swimming and shellfish harvesting. State fecal coliform standards to protect primary contact recreation requires a geometric mean count that does not exceed 200 colonies/100 mL based on five consecutive samples in a 30-day period and no more than 10% of the samples can exceed 400 colonies/100 mL. To protect for shellfish consumption, the geometric mean shall not exceed 14 colonies/100 mL and no more than 10% of the samples can exceed 43 colonies/100 mL (SCDHEC, 2004). Since only a single fecal coliform count is collected at each site during SCECAP surveys, compliance with the standards cannot be strictly determined, but the data can provide some indication of whether the water body is likely to meet standards. For SCECAP, we consider any sample with $\leq$ 43 colonies/100 mL to be good. Samples with > 43 colonies/100 mL and < 400 colonies/100 mL represent fair conditions (i.e., potentially not supporting shellfish harvesting) and any sample with > 400 colonies/100 mL represents poor conditions (i.e., potentially not supporting primary contact recreation).

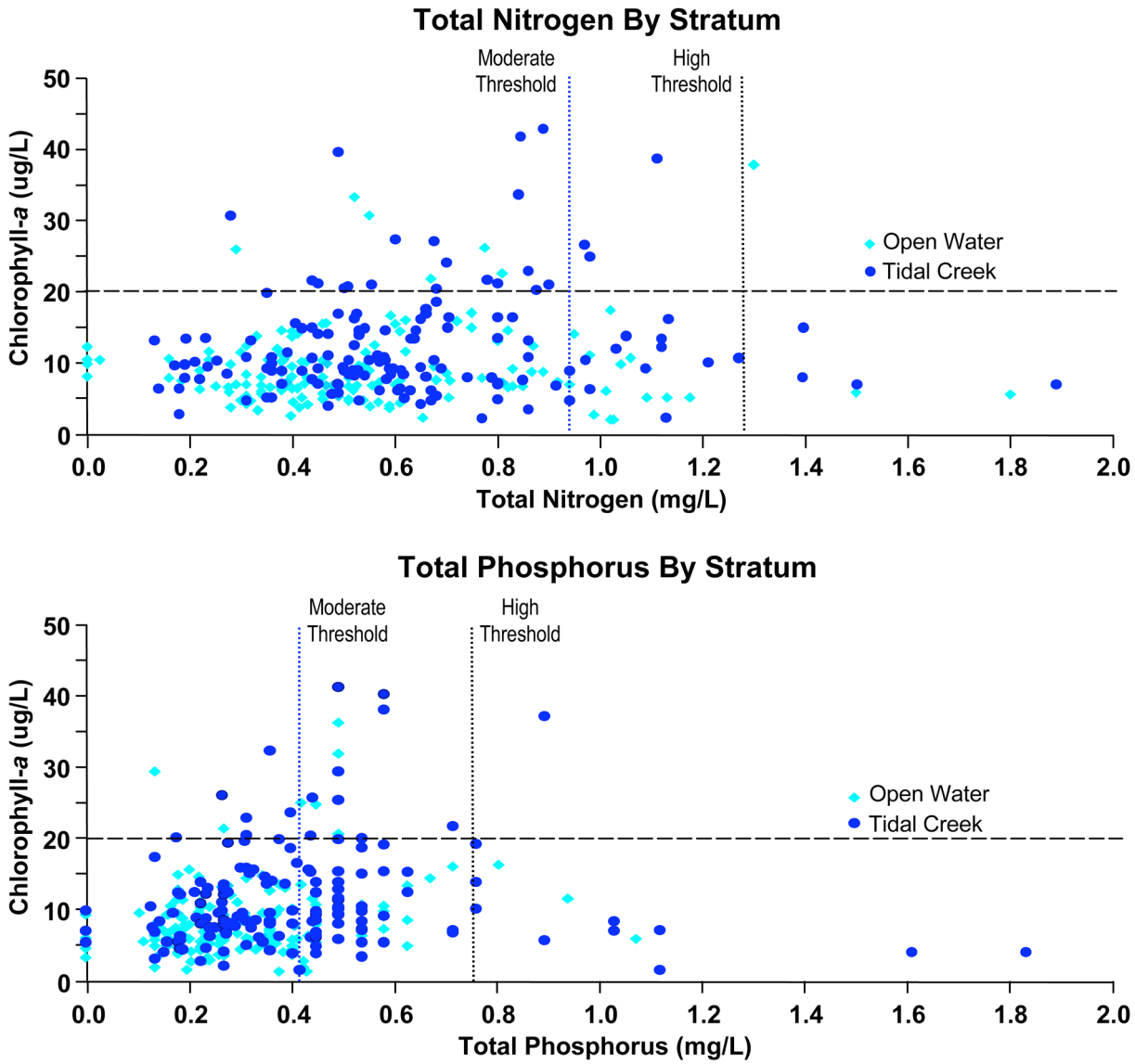

Figure 3.2.5. Summary of chlorophyll-a versus total nitrogen (TN) and total phosphorus (TP) measures collected at SCECAP sites sampled from 1999-2004. The vertical dotted lines represent the 75th and 90th percentile values based on a historical database (SCDHEC, 1998a). The horizontal dotted line represents the concentration of chlorophyll-a that is considered to be high by Bricker et al. (1999) and the USEPA (2004).

The arithmetic mean of fecal coliform measurements obtained during the 2003-2004 statewide assessments were 21.0 colonies/100 mL in open water and 80.2 colonies/100 mL in the creek sites (data online). This difference was statistically significant ($p < 0.05$) and more than double the mean fecal coliform concentrations observed in the 2001- 2002 survey (Van Dolah et al., 2004a). The relatively high mean for tidal creeks was largely due to the presence of very high fecal concentrations (range of 500-900 colonies/100 mL) at four tidal creek sites (R032046, RT032174, RT042062, and RT042194). Two of those sites were located in the upper Ashley River, which also had high nutrient concentrations. None of the open water stations had fecal coliform concentrations > 130 colonies/100 mL. Using the SCECAP criteria, approximately, 88% of the state's open water habitat also had good fecal coliform concentrations, 12% had moderately high fecal coliform concentrations and no sites had coliform colony counts > 400 colonies/mL (Figure 3.2.2). Approximately 78% of the state's creek

habitat was considered to have good fecal coliform concentrations, 16% was not likely to be suitable for shellfish harvesting and 6% had coliform concentrations considered to be very poor and not likely to be suitable for primary contact recreation or shellfish harvesting (Figure 3.2.2). The locations of sites that had moderately high to very high fecal coliform counts are provided in Appendix 2.

Even though the mean values of fecal coliform concentrations were much higher in both habitat types compared to the 2001-2002 survey, there was not a substantial change in the percentage of the state's habitat that had undesirable bacterial levels (Figure 3.2.6) The higher fecal coliform counts observed in creek habitats is most likely due to the proximity of these small drainage systems to upland runoff from both human and domestic wastes as well as wildlife sources, combined with the lower dilution capacity of creeks compared to larger water bodies. Greater protection of tidal creek habitats is warranted in areas where upland sources of waste can be identified and controlled.

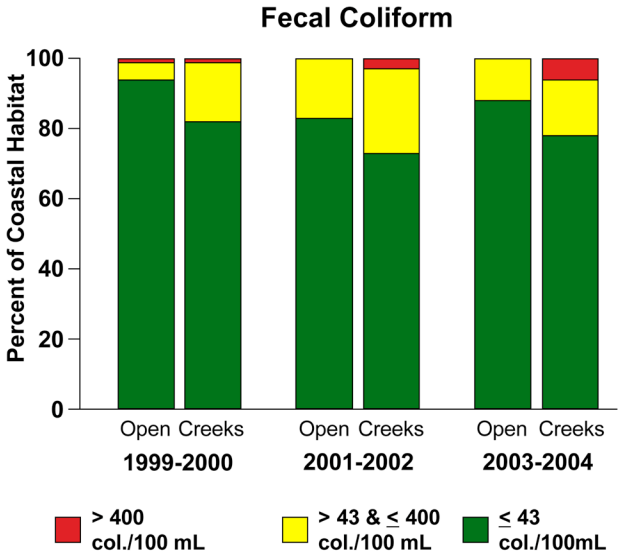

Figure 3.2.6. The percent of the state's coastal habitat representing various fecal coliform concentrations that are considered good (green), fair (yellow) and indicative of possible unsuitability for shellfish harvest, or poor (red) and indicative of possible unsuitability for primary contact recreation and shellfish harvesting during the three survey periods conducted to date.

Turbidity

Measures of water clarity provide an indication of the amount of suspended particulate matter in the water column. Exceptionally high turbidity levels may be harmful to marine life. South Carolina's estuarine waters are naturally turbid compared to many other states. SCDHEC has recently developed a maximum saltwater state standard for turbidity of 25 NTU. This corresponds to the 90th percentile of the SCDHEC saltwater database, which was obtained primarily from the larger estuarine water bodies. The 75th percentile of turbidity values obtained from SCECAP sampling was 15 NTU. Therefore for SCECAP, turbidity values ≤ 15 NTU are considered to be good, values > 15 NTU and ≤ 25 NTU are considered to be fair, and values > 25 NTU are considered to be poor because they contravene the SCDHEC standard.

While the SCECAP program recognizes the need to have turbidity standards, the standards are not incorporated into our overall water quality index at this time. Mean turbidities measured in the 2003-2004 survey by this program were 21.9 NTU in tidal creeks and 12.4 NTU in open water habitat (data online), which are very similar to the means noted in previous survey periods (Van Dolah *et al.,* 2002a, 2004a). As observed in the previous surveys, the difference between habitats was statistically significant ($p < 0.001$). Based on the single measure of turbidity taken at each station, approximately 29% of the tidal creek habitat exceeded the State standard, whereas only 7% of the open water habitat exceeded the standard (data online). Turbidity levels in tidal creeks may be naturally higher due to the shallow depths of these systems (i.e. surface samples are often within 1-2 m of the bottom) combined with re-suspension of the bottom sediments due to tidal currents. Because of the high turbidity levels observed in tidal creek habitats over the six years sampled by SCECAP (Box 3.2.1), this program has elected to not include this parameter in the integrated water quality index.

Integrated Assessment of Water Quality

SCECAP has developed an integrated measure of water quality using multiple parameters combined into a single index value (Van Dolah *et al.*, 2004a). Six parameters are included in the index: dissolved oxygen (DO), pH, total nitrogen (TN), total phosphorus (TP), chlorophyll-*a* concentrations, and fecal